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REPORT ON WATER POLLUTION - GILA RIVER SUB-BASIN

Public Health Service
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REPORT
ON
WATER POLLUTION CONTROL

GILA RIVER
DRAINAGE BASIN

1952

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REPORT ON WATER POLLUTION

GILA RIVER SUB-BASIN

February 1, 1952

Prepared by:
FEDERAL SECURITY AGENCY
Public Health Service
Western Gulf and Colorado Drainage Basin Office
in cooperation with:
Arizona State Department of Health
and
New Mexico Department of Public Health

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INTRODUCTION

The Federal Water Pollution Control Act, Public Law 845, passed by the 80th Congress in June 1948, requires the Surgeon General of the Public Health Service to cooperate with other Federal agencies, with State and interstate water pollution control agencies and with municipalities and industries in the preparation or adoption of comprehensive programs for eliminating or reducing the pollution of interstate waters and tributaries thereof, and improving the sanitary condition of surface and underground waters.

In developing these programs, due regard must be given to improvements necessary to conserve the Nation's waters for public water supplies, propagation of fish and aquatic life, recreational purposes, agricultural, and other legitimate uses.

Recognizing the fact that full technical information was not available to permit the development of such comprehensive programs immediately for most of the Nation's waters, the Public Health Service envisioned the development of a series of reports to cover the interim period prior to the development of comprehensive water pollution control programs. The first of these reports were the Summary Reports which were prepared for the 15 major drainage basins of the country on the basis of information readily available as of July 1, 1950. The second group of reports of this series, of which this is one, are reports on several sub-basins of the country's major drainage basin areas. Since development of comprehensive water pollution control programs is to proceed as rapidly as conditions permit, only a limited number of these interim sub-basin reports are to be completed, and the majority of these will be for interstate sub-basin areas. These reports are based on available data and will provide a reference point for measuring progress; provide a guide to needed additional data; provide a basis for the logical development of comprehensive programs; provide a basis for approval of loans to States, interstate agencies and municipalities at such time as the Congress makes available funds for this purpose; and serve to inform the public on the water pollution control problem and needs for the sub-basin concerned.

This report is based upon data available as of February 1, 1952, and has been compiled through and in cooperation with the State and interstate water pollution control agencies, but should not be considered a detailed engineering investigation of the Gila Basin. Through these cooperating agencies additional data have been obtained from other State officials, county and city officials and representatives of industry. Federal agencies also have been of great assistance.

The sub-basin reports present information about the ways the water resources of the area are used, the pollution entering these water resources and the resulting damages, the benefits which may result from pollution prevention and abatement, pollution prevention →

measures now in effect, and those which appear to be needed.

Since the sub-basin reports are based on data which are presently available, they do not discuss the present and future best uses of the waters of the sub-basin as such uses are related to pollution control. Such considerations will be included as a part of the comprehensive water pollution programs which will be developed later.

The deficiencies in data and the gaps in information indicated in these sub-basin reports are as significant as the presentation of available facts and statistics. They indicate the work that still needs to be accomplished by water pollution control authorities for the preparation of comprehensive programs.

Data and knowledge now available are sufficient, however, to permit the immediate solution of many of the pollution problems within the Gila Basin without awaiting the results of additional surveys and studies.

A sincere effort has been made by all who contributed to this report to present a fair picture of the complex water pollution problems in the Gila Basin and to present reasonable conclusions and recommendations. It is our hope that this report, as a step in the cooperative development of an ultimate comprehensive water pollution control program, will help in safeguarding the water resources of the Gila Basin.

GILA RIVER BASIN
LOCATION MAP

GILA RIVER BASIN

EXISTING PRIMARY WATER USES

FEDERAL SECURITY AGENCY
Public Health Service
DIVISION OF WATER POLLUTION CONTROL
MAP NO. 1

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The Public Health Service wishes to acknowledge the full cooperation and valuable assistance received during the preparation and review of this report from the following State agencies:

Arizona State Department of Health
New Mexico Department of Public Health
Arizona Game and Fish Commission
New Mexico Department of Game and Fish

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Department of the Army
Corps of Engineers

Department of the Interior
Fish and Wildlife Service
Geological Survey
Bureau of Reclamation
National Park Service
Office of Indian Affairs

Department of Agriculture
Soil Conservation Service

Valuable data also were obtained from the Research Division, Valley National Bank, Phoenix, Arizona.

SUMMARY

The Gila River Basin includes a vast area of approximately 64,450 square miles, very minor parts of which drain to and from Mexico or are enclosed in desiccating basins. The Gila River is an interstate stream--it and its tributaries draining a part of southwestern New Mexico and all of southern Arizona.

Two tributaries of the Gila (Santa Cruz and San Pedro Rivers) are international water, but insofar as is known, neither constitute an international pollution problem.

In spite of the vast area included in this basin, roughly equal to that of the New England states combined, water is in extreme shortage owing to the low precipitation and high evaporation characteristic of the arid Southwest.

Water, minerals, agricultural and forest lands are the natural resources underlying the basic economy of the Gila Basin. Virtually all of the principal industries, except the lucrative tourist services, are dependent upon these natural resources. Municipal use, irrigation, and ore concentration form the principal water demands of the Gila Basin. Underground sources supply more than one-half of the water used in the basin. Recreational use is important only in the headwater areas, on most of the reservoirs, and the larger irrigation and drainage canals.

Water pollution from man-made sources is not a problem of general magnitude at the present time--largely because of the installation of effective waste treatment facilities at all of the larger sewered communities. However, because both ground and surface waters are extremely limited and often subjected to repeated usage, water pollution is of local significance but easily could become a very serious general problem with any relaxation of waste treatment standards.

At the present time there are 77 sewered communities within the Gila Basin, serving approximately 346,000 individuals--or roughly 50 percent of the total population. Only two of the sewered communities lack waste treatment facilities, and in one instance a plant is under construction. Of the 77 sewage treatment plants, 27 are primary and serve 74,000 people. The remaining 48 plants, serving 263,000 people, provide secondary treatment. About two thirds of the plants are considered of acceptable design and operation by the State authorities.

The major needs for pollution abatement in the Gila Basin at the present time are: (1) fringe areas around the larger cities that should be served by sewer extensions; (2) many relatively large communities that remain unsewered; and (3) certain large migratory labor camps with unsatisfactory waste disposal facilities. The unsewered, often intensely populated urban fringe areas, as well as the larger unsewered communities are believed to constitute a potential threat to the sanitary quality of

the underground water resources although further study will be required for evaluation of their actual public health significance. The State of Arizona, in which the underground water quality problem is centered, recognizes these potential sources of pollution as indicated by the additional waste treatment requirements listed in Appendix II.

Industrial wastes are not known to present a serious general problem in the Gila Basin. Probably the most damaging industrial pollution stems from certain meat packing establishments located in irrigated areas where livestock watering is a common water use downstream.

Salt and silt, natural pollutants which in some measure have been accentuated by the activities of man, constitute serious water pollution problems in many areas of the Gila Basin.

In some localities, dissolved salts are sufficiently high in both surface and underground water sources to exceed the tolerance limits for both agricultural and domestic uses. Silt constitutes an extremely important pollutional problem, both economically and sociologically, generally throughout the basin. Not only is the loss of fertile top soil through extensive erosion reducing the productivity of the land, but the waterborne silt--dropped as the flood charges recede--aggrade the stream beds greatly increasing costs for flood protection to the land, to highway and railroad bridges, and the costs of maintaining the extensive irrigation structures.

The cost of the specific water pollution control measures needed at the sewered communities and by industries within the Gila Basin is estimated at $1,000,000 and $175,000, respectively (1948 cost figures). In addition, waste collection and treatment facilities in the amount of $8,970,000 are needed at communities not currently sewered. Further knowledge of the sanitary quality of waters within the Gila Basin presumably will reveal some additional needs for both industries and municipalities.

CONCLUSIONS

1. Current water demands consume virtually all of the surface waters of the Gila Basin and, in large sections, have over-exploited the underground resources as well.

2. Because water is in such extreme scarcity, none is available for the dilution of sewage or industrial wastes. Effluents from municipalities are eagerly sought for irrigation water and a low sanitary quality does not receive the concern generally held by water users in less arid regions. An extremely high degree of treatment of all wastes is required in the interests of public health.

3. The existing development of the Gila Basin could not be maintained in the face of any significant degradation of water quality. Further development of the basin area appears to depend, in very large measure, upon the provision of additional water of suitable quality. Additional water might be provided by additional conservation or reclamation of existing waters and/or by diversion from the Colorado River. The first two measures in particular will demand strict surveillance over sanitary quality.

4. The State agencies concerned with water pollution have made commendable progress in securing waste treatment at all but two of the 77 sewered communities of the basin. One of these communities is now constructing sewage treatment facilities, the other--with only 400 inhabitants--remains the sole sewered community of the Gila Basin lacking some type of waste treatment. The State agencies lack sufficient funds and technical personnel to investigate and evaluate other possible sources of pollutants or to draft and execute an effective comprehensive pollution control program that will assure clean waters in the future.

5. Additional basic information is a prerequisite to the formulation of a comprehensive program of pollution control. The needed data will involve further knowledge of the domestic and industrial waste loading of the waters, the self-purification characteristics of the water resources, a quantitative evaluation of the damage done by pollution, and the relationship between water quality and irrigation practices. In the Gila Basin, no distinction should be made between the surface and underground resources when considering the effects of pollution.

6. A number of pollution abatement measures currently are recognized as essential to safeguard public health. These include new collection systems and waste treatment facilities in some unsewered communities, the extension of collecting systems in certain urban fringe areas, effective labor camp sanitation--all of which may require new or additional waste treatment facilities. Lack of data needed for drafting a comprehensive program should, in no way, delay provision of these measures currently recognized as needed.

7. The State of Arizona does not have adequate comprehensive water pollution control legislation.

RECOMMENDATIONS

It is recommended that:

1. A comprehensive program of water pollution control for the Gila River Basin be developed as a guide to the most effective use of the limited water resources and to establish a recognized policy by which adequate water quality will be preserved in the future.

2. Current deficiencies in basic information concerning pollution and its effect upon municipal, industrial, and agricultural water uses be corrected at the earliest possible time so that the degree of additional treatment required to secure a desired downstream water quality can be determined. Deficiencies of basic data, however, should not prevent immediate action on pollution abatement measures now known to be needed.

3. Acceptable and feasible standards for the sanitary quality of irrigation water be developed and applied so that damages to this essential water use can be assessed and remedial measures installed, if needed, at the earliest possible date.

4. A single agency be established in each State to administer the water pollution control program and that this agency be representative of all groups having valid interests in water uses and pollution control.

5. All municipal State and Federal agencies, as well as industries, organizations, and individuals having interests in water uses affected by pollution, be invited to cooperate with the official water pollution control agencies in forming a comprehensive pollution abatement program and in emphasizing to the general public the recognized needs for pollution abatement measures.

6. Sufficient State funds be provided to permit the State water pollution control agencies (1) to increase their technical staff commensurate with needs; (2) to expedite the development and conduct of a comprehensive pollution control program (3) to develop a sound educational program for the public and for industry; and (4) to promote and assist in community planning for effective pollution abatement measures.

7. Municipal and industrial waste treatment plant construction, within currently recognized needs, be expedited.

8. A basin-wide program be expanded to assure acceptable levels of maintenance and operation at all waste treatment plants.

9. Soil conservation and groundwater investigational programs be expanded and accelerated in certain sections of the Gila Basin, particularly in the mid-basin area where such activities would have significant effect in increasing water percolation to groundwater storage and in recognizing and reducing water pollution.

10. The State water pollution control agencies be placed on the mailing

lists of other State and Federal agencies to receive data, information, and notices of proposed studies that have a bearing on water pollution and its control and on water resources development.

Historical Background

The early history of the Gila Basin can be traced only by the archeologist and the geologist for none of the residents prior to the coming of the white man ever developed a written language. This is surprising considering the very advanced civilization attained by the aborigines in other arts and crafts.

Ruins of great communal dwellings and storehouses, as well as pottery, arrowheads, and other artifacts bear evidence of early inhabitants in great numbers--perhaps as many as 200,000 who occupied the basin area about 1200 A.D. The aborigines faced much the same water problems as did the 19th century immigrants to the Gila country. The need for water converted the prehistoric inhabitants into competent engineers who constructed the first irrigation canals of the Gila Basin. Reputedly, the first large prehistoric irrigation canal was constructed in the Salt River valley near Tempe. Traces of about 150 miles of ancient canals are found in many level parts of the Gila Basin, and these served as handy avenues of travel for the early white men. Many of the prehistoric canals were reconstructed and enlarged by the white pioneers and, as a tribute to the engineering skills of the unknown prehistoric tribesmen, some of the major irrigation canals of today follow the exact grades of those constructed by the long-dead aborigines.

Prolonged drought presumably reduced the numbers of the Indians that the area would support and an equilibrium between man and available water for irrigating his food crops eventually was established.

The first white man to visit the basin probably was Fray Marcos de Niza, Spanish explorer and missionary who reportedly entered southern Arizona in 1539. Coronado's expedition of 1540 entered the San Simon Valley from the south and traversed the Gila and San Francisco Rivers enroute to the north and east. The Gila country subsequently was visited by many Spanish conquistadors fanning out from the Spanish capital of the New World--Mexico City--in search of gold and converts during the 16th century. Padres of these expeditions established missions along the routes of travel--many of which were staffed by Resident Fathers as early as 1700. A few permanent communities developed about the missions, but lack of water seriously limited colonial expansion of the country.

Real development of the Gila Basin followed the arrival of the Mormon pioneers about 1872 and the building of the railroads shortly thereafter. The Mormons brought expert knowledge of irrigation by which the difficulties experienced by earlier settlers in developing the water resources were overcome. An influx of white population rapidly followed the development of extensive irrigation. Concurrently, mining of ore of sufficiently high quality to support shipment to Wales for refining, attracted many other settlers.

The present-day agricultural empire of the Gila Basin was founded in 1910 with the completion of the Roosevelt Dam on the Salt River--the first major storage project of the basin which remains the largest masonry dam in the world today. Storage and regulating dams on all Gila tributaries of consequence followed during the ensuing 30 years.

The final chapter in the Gila Basin history includes the amazingly rapid expansion of the area following the full development of both surface and subsurface waters. This is probably best illustrated by the population increase of some 13-fold which has occurred since 1900 in those counties of the Gila where irrigation is most widely practiced.

Physical Description

The Gila Basin forms a rectangular watershed on an approximately east-west axis. It includes a small portion of southwestern New Mexico and virtually all of southern Arizona. In the interest of obtaining full coverage of the area, several small desiccating basins and two minor drainages discharging intermittently into Mexico also are included under the Gila Basin. The total area involved is about 64,450 square miles, or approximately that of all the New England states combined.

The Gila Basin is rimmed on the northern and eastern flanks by high mountains. Elevations within the basin range from 12,600 feet at Humphrey's Peak, near Flagstaff, Arizona, to approximately 100 feet at the confluence of the Gila and the Colorado near Yuma, Arizona. The river enters Arizona from New Mexico at an elevation of approximately 3,800 feet.

The Gila River flows for almost one-half of its 654 mile course within a series of steep-walled canyons alternating with relatively wide and flat valleys. Both canyons and valleys are rimmed by mountain ridges rising to elevations of 7,000 to 10,000 feet. The major tributaries joining the Gila in its upper section are the San Francisco from the north and the San Pedro, of Mexican origin, from the south.

Near Phoenix, the Gila emerges from the canyons onto a broad desert wasteland of successive wide valleys transected by low ranges of hills. In the lower section, the Gila receives the Santa Cruz River, which originates in the mountains of southern Arizona, flows southward into Mexico, and then hairpins northward across a wide desert that absorbs all but extreme flood flows. The Salt River--the largest tributary which receives its name from natural saline extrusions near Globe--rises high in the timbered White Mountains of east-central Arizona to be joined by the Verde from the Central Arizona plateau and finally to meet the Gila on the broad open plain near Phoenix. Lower tributaries of the Gila also include; the Agua Fria from the timbered Mingus Mountains of central Arizona, and the Hassayampa heading in the Prescott National Forest of central Arizona.

Streams originating within the Gila Basin attain their maximum flows during the late winter and early spring when the mountain snows are melting. Precipitation occurs mainly during the long rains of late winter and the short, often violent, thunderstorms of late summer--with the intervening periods being virtually rain-free. Most of the Gila watershed has an annual rainfall averaging less than 10 inches and only in the few high mountain areas does the rainfall exceed 20 inches. Maximum precipitation in the basin is believed to develop in the Black River headwaters area where the Forest Service estimates an annual average precipitation approaching 40 inches. The evaporation rate is extremely high, ranging from 77 to 120 inches per year in different parts of the basin. This, in association with a rainfall of but 3 to 20 inches per year, results in a marked net loss of surface water throughout the basin.

All major rivers of the Gila Basin are unique in that they are subject to such a degree of control and utilization that only severe flood waters reach their mouths. These infrequent floods, however, can be

very damaging particularly in the intensively populated flatlands of the Phoenix area, when river discharges exceed available water storage capacity. As an example, the main-stem Gila, twelve miles above its mouth has drained an area equal to that of the State of Michigan. The river at that point, however, flowed as a flash flood of 420 acre-feet on only three days, during a six-year period between October 1941 and October 1947. The virgin flow of the river during the twenty-year period, 1919-1938, approximated 1.32 million acre feet annually. The Gila, as a free river, terminates below Coolidge Dam.

The factors of low rainfall, high evaporation and transpiration losses, storage, and utilization combine to produce intermittent flows in reaches of virtually every river of the Gila Basin. Intermittent flows of the major streams usually develop in the more populated areas where all available water is used and reused for irrigation. This situation complicates the problem of waste disposal from the populated areas.

The Gila Basin contains the sunniest populated area of the United States, the average number of clear days exceeding 240, and in parts 280, each year. Temperatures are high; over most of the basin 100° F. in the shade is recorded frequently throughout the long summer that extends from April to November. The period between the first killing frost of the fall and the last of the spring is short, exceeding three months only at the higher elevations. In the lower sections of the basin, frost-free periods of several year's duration are common.

Average annual air temperatures throughout the basin range from slightly below 50° F. to above 70° F. The extremes of air temperatures recorded at Thatcher, in the upper part of the basin, are 7° F. and 116° F. At Phoenix, in the central section, the extremes of recorded temperature range from 16° F. to 118° F. and at Mohawk, in the lower basin, from 16° F. to 126° F.

The upper Gila Basin in New Mexico and eastern Arizona contains some of the most primitive and sparsely populated areas of the United States as illustrated by the fact that the Gila Cliff Dwellings National Monument--containing some spectacular prehistoric ruins--lacks even an access road. Most of the remaining sections of the basin, exclusive of the mountainous areas and the irrigated lands, are desert wastelands.

Vegetation of the Gila Basin varies widely, reflecting differences in elevation, temperature, and precipitation. Aspens, fir, spruce, and pine are common at elevations above 6,000 feet. Commercial stands of timber, mostly ponderosa pine, are found at the higher elevations on several areas of the Gila Basin. The largest block of timber is located in the Apache National Forest and the Fort Apache Indian Reservation in the headwaters of the Salt, Black, and Blue Rivers. Grasses interspersed with the desert and semi-desert shrubs--chaparral, scrub oak, pinon, and juniper--are found between elevations 3,000 to 8,000, in densities decreasing at the lower altitudes. The desert vegetation below 3,000 feet generally is sparse except along the streams. Principal desert vegetation is cacti, creosotebush, and sage. Salt cedar, mesquite and other phreatophytes often form extremely dense growths along stream beds.

Economic Development

The economy of the Gila Basin since the earliest prehistoric days has rested securely upon agriculture. With the arrival of the white man, attracted by the lure of gold, the mining of non-ferrous metals rapidly became the second pillar of regional economy. More recently, manufacturing and tourist services have constituted valuable segments to the Gila Basin economy.

Statistics for 1950* show that agricultural crops and livestock produced in the State of Arizona--about three-fourths of the former and an unknown fraction of the latter being produced in the Gila Basin--were valued at $186,037,000 and $89,858,000, respectively. Mineral production of Arizona that year was valued at $201,034,000--about 70 per cent being produced in the Gila Basin. Manufacturing production of Arizona in 1949, exclusive of smelter operations and non-taxable war contracts was valued at $130,666,830 of which approximately 90 per cent was produced in the Gila Basin. According to local statistics, more people now visit Arizona each year than reside in all of New England. Tourist expenditures in Arizona exceed $100,000,000 annually--a very large percentage being spent in the Gila Basin country.

In the early days, agriculture was largely a matter of local subsistence; farmers would settle along those streams most easily diverted for irrigation and produce their own needs with some surplus for their urban neighbors. Shortly after the turn of the 20th century, intensive development of the waterways provided large-scale irrigation and the accompanying agricultural expansion quickly attracted new people and supported new industries. The development of irrigated acreage of the Gila Basin is best illustrated by the following summary:

Approximate thousands of acres under irrigation

	1900	1910	1920	1930	1940	1950
Gila Basin	170	310	415	500	560	830
State	200	325	475	605	680	1,000
% in Gila Basin	85	95	87	83	82	83

The principal agricultural products of the Gila Basin at the present time are cotton, livestock, alfalfa, seed crops, vegetables, milk, citrus fruits, feed grains, and flax.

Mining developed in parallel manner. Early-day prospectors found rich lodes--most of which were rapidly exhausted but supported a colorful boom economy while they lasted. Mining eventually has stabilized around large operations that can economically work comparatively low-grade ore. Those operations are widely scattered--mostly over the eastern and southern portion of the basin. Copper, gold, silver, lead, and zinc are the principal minerals produced. During 1950, Arizona led the nation in the production of these five non-ferrous metals with a combined value of

* Statistics furnished by the Research Division, Valley National Bank, Phoenix, Arizona

$198,997,000. Development of the mining industry in Arizona--some 70 per cent of the minerals being produced in the Gila Basin--may be traced by the following data on gross value in thousands of dollars:*

	Copper	Gold	Silver	Lead	Zinc	Total
1912	59,288	3,785	2,119	350	604	66,146
1920	101,750	4,961	5,920	958	118	113,707
1930	74,217	3,073	1,819	422	78	79,681
1940	63,544	10,318	5,031	1,327	1,947	82,167
1949	141,450	3,815	4,491	10,607	17,523	177,894
1950	167,773	4,141	4,820	7,123	17,176	201,034

* Data from Research Division, Valley National Bank, Phoenix

The population increase has kept pace with the expansions of agriculture and mining. Arizona was the second fastest growing state in the Union during the half century between 1900 and 1950. It occupied the same comparative position during the decade 1940-1950. The Gila Basin consistently has attracted about four-fifths of the State population as shown by the following Arizona population statistics:

	1900	1910	1920	1930	1940	1950
Gila Basin	89,665	164,051	274,744	359,104	403,170	629,436
Arizona	122,931	204,354	334,162	435,523	499,261	749,587
Percentage of State pop. in Gila Basin	73	80	82	83	81	84

The urban-non-urban population ratio of the Gila Basin in 1950 was 1.41:1 in comparison with the Arizona State ratio of 1.23:1.

Arizona leads all other States of the Union in the gain in per capita income during the past decade, this item having risen by 254 per cent. Estimated per capita income in Arizona was $468 in 1940 and $1,165 by 1950.

The Gila Basin now supports many modern, growing communities--the two largest being Phoenix and Tucson. It is traversed by a network of excellent highways--the most important one being U. S. 80, which carries the bulk of the wintertime transcontinental motor traffic. The basin is well served by the mainline of the Southern Pacific Railroad's Sunset Route and by important branch lines of the Atchison, Topeka and Santa Fe Railroad. The main flights of both American and Trans-World Airlines enter the Gila Basin in addition to local air service to the more important communities by the Bonanza and Frontier Regional Airlines.

Several large military establishments are found within the Gila Basin, as are important defense industries. The former include Fort Huachuca, Davis-Monthan, Luke Air Force Base, Williams Air Field, Litchfield Naval Air Facility, Navajo Ordinance Depot, and the Marana Air Base. The more important defense plants include Reynolds Metals Corporation, Goodyear

Aircraft Corporation, Air Research, Motorola Corporation, Ground Central Aircraft Company, and the Howard Hughes Company. The recent expansion of both military and industrial establishments have, in some instances, severely taxed the community facilities of adjacent areas.

USES OF WATER RESOURCES

Waters of the Gila Basin are used principally for municipal supplies, irrigation, recreation, and ore concentration. Surface water supplies have proven inadequate to meet the rapidly increasing demands and an extensive development of the underground water resources--to the point of marked over-exploitation--has occurred.

Domestic water use, by sources, in the Gila Basin is indicated by January 1950 data in the following table:

Source	No. of Communities	Estimated Population Served	Average Output M.G.D.
Surface	4	14,450	0.940
Underground	35	292,576	37.783
Combination	5	188,800	39.572
	44	495,826	78.295

In addition, there are 4 communities serving an estimated population of 4,995 with an unknown quantity of surface water, 12 communities serving an estimated population of 9,360 with an unknown quantity of underground water, and two communities supplying approximately 15,700 consumers with an unknown quantity of water from combination surface and underground sources.

The quantitative data listed above indicate a basin-wide average per capita use of about 158 gallons per day. The per capita use is considerably higher in the larger cities as indicated by an average daily use of 192 gallons per consumer in Phoenix. Undoubtedly, the seasonal variations about the annual averages are extremely wide for large volumes of water are used during the summer for air conditioning and lawn irrigation--particularly in the larger cities. Phoenix, for example, had a daily usage of 82 million gallons during the summer of 1951 in comparison with an annual average daily use of 37 million gallons.

Irrigation uses--and reuses--a tremendous volume of water provided by large storage reservoirs located on every principal perennial stream of the basin and by heavy pumping of the underground waters. No natural lakes of appreciable size are found in the Gila Basin. There are eight major irrigation storage reservoirs in the Gila Basin--ranging in capacity from 57,800 acre feet at Mormon Flat Reservoir to 1.4 million acre-feet at Roosevelt Reservoir with a combined reservoir storage capacity exceeding 3.4 million acre-feet. Except for occasional flash floods, no river flows other than highly mineralized return irrigation water occur below many of the irrigated lands.

The quantity of water applied annually per acre of land under irrigation varies widely with the type of soil, kind of crop, efficiency of farm management and--perhaps of greatest importance at the present time--the quantity of water available. Generally speaking, the net duty of water varies from about 2.3 acre-feet per acre for truck crops to about

5.0 acre-feet per acre for alfalfa and grain. The overall average net duty of water is estimated at 4.0 acre-feet per acre.

Sufficient water for irrigation is not available from surface sources and the use of ground water to supplement surface sources has increased rapidly during the past 15 years as indicated by the following tabulation of irrigation water pumped from underground sources in the Gila Basin between 1941 and 1950.

IRRIGATION WATER PUMPED FROM WELLS IN GILA BASIN*
(Data in Thousands of Acre Feet)

County	1943	1944	1945	1946	1947	1948	1949	1950
Cochise	a	a	a	33,800	37,000[b]	45,000[b]	58,000	70,000
Graham	35,000[b]	52,000[b]	35,200[b]	120,600	100,000[b]	110,000[b]	40,000	90,000
Greenlee	7,100	9,500	8,300	21,000	26,000	27,000	15,000	30,000
Maricopa	1,104,000[b]	1,017,000[b]	1,143,000[b]	1,400,000	1,453,200	1,732,700	1,716,000	1,917,000
Pima	100,000	106,000	111,000	108,000	145,000	145,000	150,000	180,000
Pinal	515,000	530,000	610,000	660,000	700,000	850,000	1,100,000	1,000,000
Santa Cruz	15,000	12,500	18,500	24,000	25,000	28,000	31,000	21,000
Yuma	a	61,000	61,000	74,000	82,000	109,000	109,000	111,000
TOTAL				2,441,400	2,568,200	3,046,700	3,219,000	3,419,000

* Data 1941-1948 from "Pumpage and groundwater levels in Arizona in 1948." S.F. Turner and others.
U. S. Geological Survey Mimeographed release, Tucson, Arizona. 1949 and 1950 data from State Health Department.

a Pumpage not determined

b Pumpage data not complete

It is estimated that since the beginning of the 1945 irrigation season, the quantity of underground water used for irrigation has exceeded the quantity of surface water used. There is good evidence that the underground resources have been over-developed in several important areas. During the past 10 years, the groundwater table has dropped about 45 feet in the Queen Creek area; 35 feet in the Tempe-Mesa-Chandler area; 30 feet in the Phoenix area; 50 feet in the Litchfield area; and 80 feet in Eloy area. Pumped water in Maricopa County--which includes the last three areas mentioned--totaled 1.85 million acre-feet during 1950.

Rainfall is not sufficient to support dry-farming. Where water is not available for irrigation, the land can be used only for grazing. During the frequent and recurrent droughts, there is not sufficient forage on much of the grazing land to support adequately a very large number of animals. In some parts of the basin, lack of water precludes all use of rangeland for livestock.

Recreation constitutes an important use of the water resources, particularly in the mountainous headwater areas. Some of the best big game habitat of New Mexico is found in the upper Gila Basin, and large numbers of hunters are attracted to that area by the deer, elk, bear, and wild turkey available. Antelope, quail, and pigeon are hunted in the open plains sections of the upper Gila. Trout fishing is reported excellent in the Middle Fork, West Fork, and the extreme upper San Francisco and the Blue Rivers. The most heavily fished trout stream of Arizona is Oak Creek--a short spring fed upper tributary of the Verde River. Most of the perennial waters of the Gila contain catfish and some small-mouth black bass in the intervening reaches between the cooler trout waters of the mountains and the plains areas where the silt loads usually become too heavy to support game-fish population in significant numbers. Most of the reservoirs of the Gila Basin support considerable recreational pressure. In the populated plains sections of the basin, the larger irrigation and drainage ditches receive considerable use for fishing, swimming, and some hunting. Outdoor recreation, other than hunting and fishing, is very popular and great numbers of people seek climatic relief in the cool mountain areas during the summer months. Increasing transient populations, concentrating along streams of the National Forest, during recent years have aggravated the problems of the U. S. Forest Service in protecting water supplies and providing adequate waste disposal.

The mining industry consumes large volumes of water principally in concentrating ores. The quantity of water used per unit of output varies widely with the mineral concerned and the process used for its concentration. Copper concentration by floatation, for example, demands about three tons of water for each ton of ore processed. Water quality is not important in copper floatation so water conservation by recycling is usually practiced. Lead and zinc floatation, on the other hand, requires about 1.5 tons of water per ton of ore processed, but the quality of water required in the process is so high that recycling ordinarily is not feasible. Incomplete coverage of the mining industry in the Gila Basin indicates a new-water demand exceeding 25 million gallons per day. Water available in the mining areas of the Gila Basin is so limited that further plant expansion to increase production appears impossible.

No information is available concerning the industrial use of water in the Gila Basin other than that for certain ore mills. Some major industrial water users in the larger cities have developed their own underground sources, but the quantity used is not known.

The quality of water obtained in the Gila Basin varies widely. In the upper Gila Valley proper, the river water is of variable quality depending upon its source and the season of the year. The water in many wells is excessively high in salts and has a high sodium-calcium ratio so their quality is generally regarded as poor for either domestic or irrigation uses. In addition, the majority of these waters contain excessive concentrations of fluorine. In the middle Gila valley, the salt content of the underground waters is lower and the water quality correspondingly higher. In the lower Gila, the salt content and sodium-calcium ratio again rises to the point that only the most tolerant crops can be grown.

The upper tributaries of the Gila, the Blue, and the San Francisco Rivers drain a mountainous country and the salt content of the surface and underground waters is low.

In the San Simon Valley, waters generally are soft with a low salt and flourine content except in the vicinity of San Simon where the Na:Ca ratio is high as is the flourine content.

Waters of the San Pedro are very low in soluble salts, soft, but usually contain excessive quantities of flourine. It was at St. David in the San Pedro valley where the relationship between flourine and mottled tooth enamel was discovered.

Waters of the Salt River and its tributaries generally are of high quality until contaminated by a build-up in mineral content from natural sources and return irrigation water. The quality of water from underground sources is lower than that of the surface waters. Much the same situation prevails in the Hassayampa valley although some local sources yield hard water with an unfavorable Na:Ca ratio and a few have excessively high flourides.

Most of the waters of the Santa Cruz basin are excellent for irrigation because of their generally low salt content and favorable Na:Ca ratio. Some local sources yield waters of much lower quality and a few sources are extremely high in dissolved salts.

It is extremely difficult to outline the chemical quality of either surface or underground waters in generalities. Marked variations in water quality are encountered throughout all areas of the Gila and, in the case of underground sources, at various depths as well.

Pollution Contributed to Water Resources

Waters of the Gila Basin receive considerable quantities of pollution from natural sources in the form of silt and mineral salts. Silt pollution originates in virtually every portion of the basin where running water is found except for the extreme headwater areas. Severe run-offs following the heavy precipitation of summer thundershowers cause heavy local soil erosion, the effects of which are felt for considerable distances downstream. Soil erosion has greatly accelerated during the past half century over most of the Gila Basin area following depletion of vegetal cover through overgrazing, improper lumbering methods, and fire. Some of the streams of the basin are heavily charged with mineral salts leached from surrounding alkaline soils and from underground mineral deposits. Mineral springs are commonly found throughout the basin--perhaps the largest being those near Globe from which, presumably, the Salt River derived its name. In the lower sections of the basin, particularly, a marked increase occurs in the dissolved solids concentration of waters which stems from repeated use of the water for irrigation with attending evaporation and leaching of minerals from the soil. In some irrigated areas, constant withdrawal of subsurface waters is required to permit fresh surface water to wash out the salts accumulating from evaporation. It appears quite certain that in some areas at least, the salt concentration of the soil is increasing as a result of irrigation although it is difficult to isolate this source of minerals from those derived from the natural salt deposits. In the heavily irrigated Phoenix area, for example, many wells have been abandoned because the gradually increasing total dissolved solids content eventually exceeded usable limits. High dissolved salt concentrations preclude use of groundwater by the Reynolds Aluminum Company at Phoenix for its industrial needs. The city water supply is used by this company only following deionization.

Pollution by the domestic wastes of sewered communities of the Gila Basin appear under control. The data listed in Tables A to F show that 75 of the 77 sewered communities within the Gila Basin provide some type of waste treatment. These serve a combined population of 346,000--or over one-half of the total basin population. Of the 75 sewage treatment plants, 27 are primary and serve a total population of 74,000. The remaining 48 plants, serving 263,000 people, provide secondary treatments. Fifty of the 75 plants are considered by State authorities as being of adequate capacity, and 55 as being operated satisfactorily. The high degree of treatment provided in the Gila Basin--which is far above the national average--stems from the firm determination to preserve the sanitary quality of the limited water resources. In practically all instances, treatment plant effluents are used immediately for irrigation.

The single exception to waste treatment at all sewered communities is the isolated joint communities of Bisbee-Lowell in the southeastern part of the basin near the Mexico border Treatment facilities have been under construction intermittently for the past ten years. Uncertainties attending the location and development of ore deposits in the immediate area--upon which the communities are largely dependent for their economic existence--have periodically interrupted plans for completion of the sewage treatment facilities. However, a bond issue recently was passed

that will assure finishing the partially completed plant.

Although waste disposal at the sewered cities of the Gila Basin is generally satisfactory, pollution of the water resources is believed to originate in many communities that have no collection system. Sanitary waste disposal in these communities is accomplished on an individual housing unit basis and, in many cases, population densities have advanced to the point where individual facilities no longer constitute an adequate answer to the community waste disposal problem. The individual waste disposal units ordinarily consist of a septic tank or cesspool that may, or may not, be followed by a drainage field or seepage pit through which the settled effluent is discharged to the subsurface waters. A seepage pit consists merely of a shaft, two or three feet in diameter, sunk to the shallowest porous strata encountered. The seepage pit lacks the filtering features of the drainage field and without doubt directly contaminate the adjacent subsurface waters. Any of these disposal methods are unsatisfactory in concentrations as the water resources can absorb only a certain waste loading without damage. Much the same situation prevails in the densely populated fringe areas surrounding many of the larger cities and into which municipal sewers have not yet been extended.

Another source of pollution to both surface and underground waters are certain of the many migratory labor camps. The extensive agricultural production in the irrigated sections of the central Gila Basin has a high seasonal demand for labor--most of which is housed in camps provided by the ranch owners. Irrespective of the sociological and economic aspects of the migratory labor problem, the fact remains that many of these camps lack acceptable facilities for the disposal of sanitary wastes. Located as they are in large areas traversed by many irrigation and return drainage ditches, pollution of waters adjacent to many of these camps seems inevitable.

There is comparatively little industrial waste produced outside the larger cities of the basin. As shown in Table D, there are comparatively few industries in the Gila Basin that are not connected to municipal sewers. Probably the most damaging pollution by industrial wastes stems from certain meat packing establishments located in irrigated farming areas where livestock watering is a common water use downstream. From a basin-wide standpoint, however, industrial pollution of the water resources is comparatively insignificant and, where it may exist, presumably is of highly localized consequence.

Mining operations, for the most part, are conducted in extremely arid sections of the basin, and water is carefully conserved by complete recycling. Occasionally, releases do occur to the detriment of any immediate downstream water uses. The typical copper mill floatation circuit has a pH of 11 from the addition of caustic. The leaching circuit is kept at pH 2.5 by the addition of sulphuric acid. The degree of pollution actually contributed to the water resources by mining operations--except for accidental spills--is not known but is generally accepted as being of little significance.

TABLE A
SOURCE OF POLLUTION
MUNICIPAL

Municipalities*	Sources of Pollution (In Number of Municipalities)	Population Served by Sewerage System	Amount of Pollution Discharged to Watercourse (In Terms of Equivalent Number of People)**
Having data on pollution load discharged to watercourse	2	180,000	7,760
Having population data available (Data on pollution load to watercourse incomplete or not available)	75	166,278	Undetermined
TOTAL	77	346,278	xxxxxxxxxxx

* Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns, significant institutions, resorts, recreational centers or other population centers.
** Includes industrial wastes discharged into municipal sewerage systems

TABLE B
SOURCES OF POLLUTION
INDUSTRIAL*

Industries*	Sources of Pollution (In Number of Plants)	Estimated Amount of Pollution Discharged to Watercourse (In Terms of Equivalent number of People)
Producing Organic Wastes	5	1725
Producing Organic Wastes	27	Undetermined
Producing Inorganic Wastes	20**	Not applicable
Producing Wastes of Undetermined Type	6 #	Undetermined
TOTAL	58	xxxxxxxxxxx

* Industries having separate outlets discharging wastes directly to watercourse.
** Includes one plant with separate sanitary sewage outfall.
# Includes one industry discharging sanitary sewage only.

TABLE C
EXISTING TREATMENT FACILITIES
MUNICIPAL

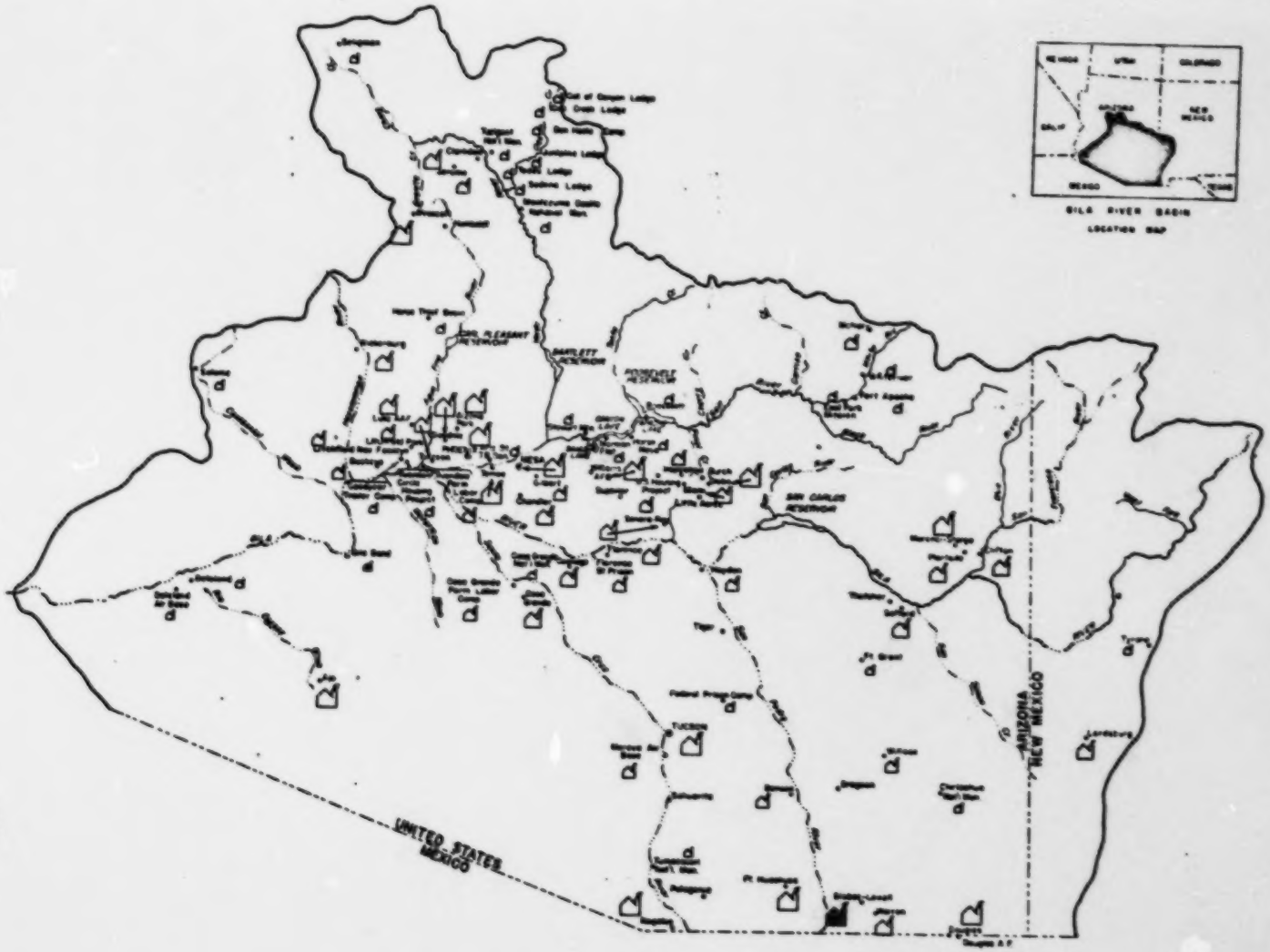
Degree of Treatment Provided	Number of Municipalities* Served	Number of Treatment Plants	Population Served
Primary	27	27	74,410
Secondary	48	48	263,468
No Treatment	2		8,400

* Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers or other population centers.

TABLE D
EXISTING TREATMENT FACILITIES
INDUSTRIAL*

Type Industry	Number of Plants	Number of Industrial Plants Having: Treatment Facilities	No Treatment Facilities	Undetermined Facilities
Food	26	20	5	1
Chemical and allied	5 **	1	4	0
Primary Metals	18 **	16	1	1
Fabricated Metal	1	1	0	0
Miscellaneous	8 ***	6	2	0

* Industries having separate outlets discharging wastes directly to water course.
** Includes one plant with separate sanitary sewage outfall.
*** Includes one industry discharging sanitary sewage only.



GILA RIVER BASIN
LOCATION MAP

SOURCES OF MUNICIPAL POLLUTION
POPULATION SERVED BY SEWERS

- 1-500
- 500-1,500
- 1,500-5,000
- 5,000 AND OVER

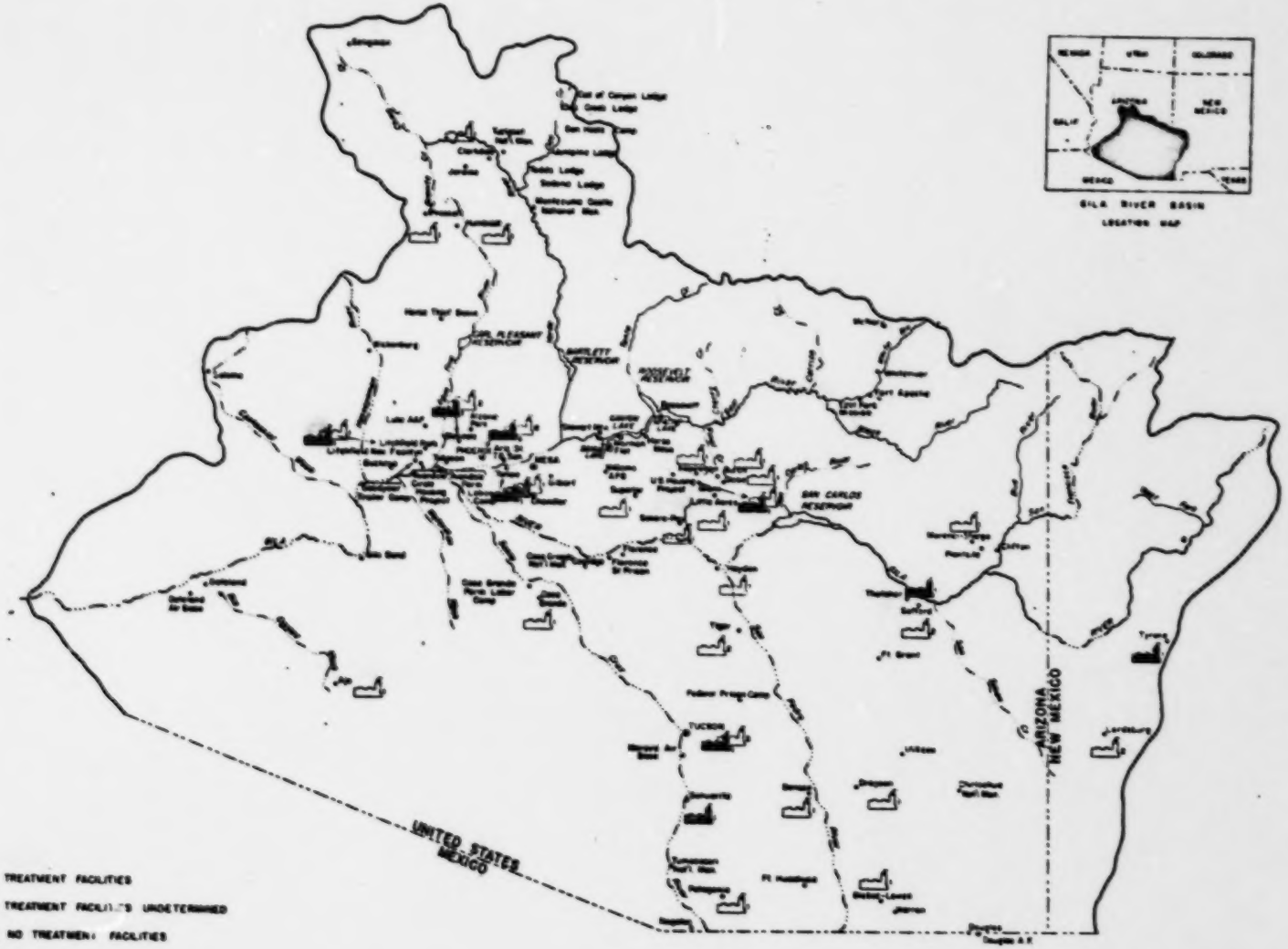
EXISTING TREATMENT FACILITIES

- MUNICIPALITIES WITH TREATMENT FACILITIES
- MUNICIPALITIES WITH TREATMENT FACILITIES UNDETERMINED
- MUNICIPALITIES WITH NO TREATMENT FACILITIES

SCALE OF MILES

GILA RIVER BASIN
SOURCES OF MUNICIPAL POLLUTION
AND
EXISTING TREATMENT FACILITIES
FEDERAL SECURITY AGENCY
Public Health Service
DIVISION OF WATER POLLUTION CONTROL
MAP NO. 2

22-A



GILA RIVER BASIN
LOCATION MAP

INDUSTRIES WITH TREATMENT FACILITIES

INDUSTRIES WITH TREATMENT FACILITIES UNDETERMINED

INDUSTRIES WITH NO TREATMENT FACILITIES

NOTE: Numbers appearing by symbols indicate total number of industrial sources of pollution in the area in the category designated

SCALE OF MILES

GILA RIVER BASIN
SOURCES OF INDUSTRIAL POLLUTION
AND
EXISTING TREATMENT FACILITIES
FEDERAL SECURITY AGENCY
Public Health Service
DIVISION OF WATER POLLUTION CONTROL
Map No. 3

22-b

Damages to Water Resources from Pollution

The most damaging pollutants to the water resources of the Gila Basin are silt and salt. Domestic wastes constitute a damaging pollutant in localized areas.

The poorly compacted friable soil found over most of the plains areas of the basin, associated with the sparse vegetation now characteristic of the lower elevations and the torrential--if infrequent--rains results in the tremendous silt loads of many rivers. Not only are the recreational values of these streams greatly reduced, but the silt dropped as the flood charges recede aggrade the stream beds which complicates and greatly increases the cost of flood protection to adjacent lands as well as at railroad and highway bridges. Silt deposits likewise aggrade irrigation ditches and vastly increase maintenance costs.

Dissolved salts from natural sources are sufficiently high in some surface and underground sources to exceed tolerance limits for both agricultural and domestic uses. In some localities an increase in dissolved solids concentration apparently has developed from evaporation and soil leaching during repeated use of water for irrigation.

Insofar as man-made pollution is concerned, the program of domestic waste treatment is well advanced at the sewered communities of the Gila Basin. When the facilities currently under construction at Bisbee-Lowell are completed, there will be but one sewered community (Gila Bend, sewered population 400) in the entire basin that lacks some degree of sewage treatment.

The complete abatement of water pollution by domestic wastes is by no means assured even under such favorable conditions. There still remain 26 communities, with a combined sewered population of 77,000, at which additional waste treatment facilities or the replacement of existing facilities are recommended by the State Department of Health.

Likewise, in so arid a region as the Gila Basin where generally no water is available for the dilution of wastes, an exceptionally high degree of waste treatment is required to safeguard public health. Most modern sewage treatment processes are far more effective in oxidizing organic wastes than in bacterial purification and the presence of a sewage treatment plant does not necessarily provide full protection to public health.

There are also several important sources of sanitary wastes--namely certain unsewered communities, fringe areas, and migratory labor camps--that may be causing considerable and widespread damage to the water resources. This contention can be substantiated only by circumstantial evidence, for quantitative data bearing directly upon the situation are wholly lacking. Public health hazards comprise the nature of damage from these sources.

Ineffectual protection to public health is provided by the individual waste disposal units used in the larger unsewered communities of the Gila Basin as well as in the unsewered fringe areas surrounding many of the

large cities. The unsewered communities range up to 5,000 inhabitants. The unsewered fringe areas generally are much larger--those about Phoenix, for example, including about 115,000 inhabitants. These population densities are well above the point where individual units can be considered as an adequate or even an acceptable answer to the community waste disposal problem. Individual sewage disposal units offer limited protection against the pollution of underground waters and, in densely populated areas, the same water strata into which the wastes are discharged may be tapped for domestic or irrigation water long before the natural processes can eliminate pathogenic organisms from the wastes.

Even less protection of both surface and underground waters is provided by the primitive waste disposal methods employed at many of the migratory labor camps. Here, pollution of adjacent irrigation waters seems inevitable. The public health hazards presumably would be disproportionately great in that the labor camps often house workers recruited from areas where sanitary standards are extremely low and among whom, it can be reasonably anticipated, the incidence of water-borne diseases is abnormally high.

Inadequately treated domestic wastes degrade the sanitary quality of the water resources. They correspondingly increase water-user risk of exposure to the waterborne enteric diseases. Bacillary and amoebic dysenteries, typhoid, paratyphoid, and the other less virulent Salmonella infestions of man are readily carried in contaminated water as are many diseases of lower animals. Other water users, in the case of the Gila Basin, might be the swimmer, fisherman, or canoeist using the larger irrigation and drainage canals for recreation as many do. It might be the field hand drinking from the irrigation ditch. It might be the communities of individuals at ranches or at the smaller hamlets that do not sterilize their water supplies. It could be the diner many miles away who consumes inadequately washed fresh vegetables flooded with contaminated irrigation water shortly before harvesting. Inadequately treated abattoir wastes, or even domestic wastes, provide a source of pathogenic organisms to livestock drinking water contaminated by these sources of pollution.

The incidence of human dysentery throughout the Gila Basin is of far more than passing interest as the following tabulation of the number of reported cases, per 100,000 population, would indicate:

County	1947	1948	1949	1950	1951	5-year mean
Maricopa	259	212	93	132	161	171
Gila	0	[a]	2,074	958	244	657
Greenlee	397	83	290	617	295	336
Graham	24	367	341	616	558	381
Pinal	162	565	819	739	1,179	693
Pima	22	93	132	150	111	102
Santa Cruz	0	470	160	107	1,597	467
Cochise	31	69	76	321	164	132
State of Arizona	169	191	229	250	282	224
United States						

No implication is intended that contaminated water alone is responsible for the abnormally high dysentery rates of the Gila Basin, but it seems entirely reasonable to assume that it plays an important role. Dysentery is transmitted by means other than water, notably by contamined foods and by insects. Nonetheless, contaminated water constitutes a very effective medium for spreading many types of gastroenteritis, including dysentery, under circumstances that permit the consumption of such water without treatment. Such an eventuality is not only possible, but quite probable particularly where irrigation canals receive both domestic wastes and recreational use as many do. The irrigation canals, although not intended for recreational use, constitute about the only surface water locally available in the more populated rural sections of the Gila Basin. It is inevitable, therefore, that the local populace--particularly children--utilize the canals for the recreational purposes normally served by natural streams in less arid regions.

BENEFITS RESULTING FROM POLLUTION PREVENTION AND ABATEMENT

Perhaps the greatest monetary benefits from pollution prevention and abatement would accrue from effective soil conservation measures to reduce the aquatic silt loads. In the Gila Basin the erosion cycle has progressed so far in most places that minor structures, such as detention reservoirs, drop structures at headcuts, and bank protection works, will be needed. Where the erosion cycle is less well developed, grazing control and effective range management will prove effective. Reduction of the silt loads in streams of the Gila Basin would be accompanied by tangible economic benefits of considerable magnitude. The benefits include the prolonging of reservoir life, the reduction in annual maintenance costs for irrigation canals, and the decreasing severity of flood damage resulting from aggrading stream channels.

Insofar as man-made pollution is concerned, the benefits arising from corrective and preventive measures are mostly those intangible--but nonetheless definite--values related to public health. Inadequately treated domestic wastes constitute a constant menace to public health. The provision of adequate treatment of both community and individual sewage is required in the interest of aesthetics as well as reducing the threat of water-borne diseases. The health problem is most acute in the heavily irrigated areas where competition for water is keen and the population is concentrated. Because the rivers are largely intermittent in these sections, the irrigation canals provide water for swimming and fishing as well as drinking water for labor campers and field workers. Effective pollution prevention measures would provide safe swimming, boating, and fishing in the irrigation and drainage canals. Such measures would greatly lessen the chance that the swimmer and field hand drinking from these sources might contract some water-borne disease. They would also give added protection to the quality of the underground water resources from which many communities and individuals obtain domestic water.

The public health significance of irrigation of food crops with sewage-contaminated waters admittedly has not been firmly established. Irrespective of the facts that eventually may be uncovered, the thought is repugnant to the average consumer and might easily lead to his boycott of fresh produce grown in those areas where irrigation water reputedly is polluted. Such an eventuality would lead to economic hardship, particularly in the Gila Basin where high-priced off-season fresh produce is grown in sharp competition with other areas.

POLLUTION PREVENTION MEASURES IN EFFECT

The overall picture of pollution prevention measures currently in effect by sewered municipalities and industries within the Gila Basin is given in Tables 1 and 2.

The prevention and control of pollution from domestic wastes of the larger and sewered communities has been well advanced by the State Health Departments of New Mexico and Arizona. Approximately one-half of the entire population within this vast basin is served by public sewer systems and all but 8,400 of the 346,300 sewered population is served by treatment plants. As shown in Table C, two-thirds of the 75 sewage plants of the Gila Basin provide secondary treatment to 76 percent of the sewered population. About two-thirds of the plants are considered of adequate design to meet present needs and a slightly higher percentage of the plants are being operated satisfactorily. (Table E). This better-than-average situation stems from an intensive pollution abatement action by the State agencies leading to an extensive post-war construction program under which one-fifth of the existing plants were built or completely modernized since 1947. (See Table G). Post-war construction provided new or acceptable sewage treatment at 14 communities of the basin with a combined sewered population currently estimated at 243,250 or 70 percent of the total sewered population of the Gila Basin.

The industrial waste picture is almost as bright. (Tables B, D, F). By far, the majority of industries within the Gila Basin are located within communities and are served by public sewers. The data on Tables D and 2 indicate the food industry--principally meat packing and beverage--constitute the greatest potential source of industrial organic polluting wastes. In some cases, heavy industrial loadings have exceeded the capacity of municipal treatment plants.

Water is in such short supply that industry can ill afford to waste it. Large users of water, such as the ore mills, ordinarily reclaim all process water for recycling. This type of water conservation also precludes the discharge of rock flour, the principal waste product of ore mills, into the streams.

Lack of quantitative data precludes even a reasonably accurate estimate of the amount of pollution kept from the waters of the basin by municipal and industrial waste treatment plants. Certainly, man-made pollution has not precluded the use of water in the Gila Basin. Water is in such extreme scarcity, however, that neither its sanitary nor mineral quality receives the concern generally held by water users in less arid regions. Use of the water, therefore, is not without greater than normal attendant danger.

Legally, the State of New Mexico places the responsibility for water pollution control, insofar as public health interests are concerned, with the State Department of Public Health. Provisions of the State Game Code place authority to enforce pollution control measures required for the protection of fish and wildlife with the State Department of Game and Fish.

TABLE E

ADEQUACY OF EXISTING TREATMENT FACILITIES

MUNICIPAL*

Number of Municipal* Treatment Facilities	Adequacy With Relation To:					
	Capacity			Operation		
	Satis-factory	Unsatis-factory	Unde-termined	Satis-factory	Unsatis-factory	Unde-termined
75	47	25	3	54	18	3

* Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers or other population centers.

TABLE F

ADEQUACY OF EXISTING TREATMENT FACILITIES

INDUSTRIAL*

Number of Industrial* Treatment Facilities	Adequacy With Relation To:					
	Capacity			Operation		
	Satis-factory	Unsatis-factory	Unde-termined	Satis-factory	Unsatis-factory	Unde-termined
44	21	12	11	20	13	11

* Industries having separate outlets discharging wastes directly to watercourse.

TABLE G

PROGRESS IN CONSTRUCTION OF POLLUTION ABATEMENT FACILITIES

Year	Municipal		Industrial	
	Sewage Treatment Plants Completed	Design Population	Waste Treatment Plants Completed	Amount of Waste Treated (In Terms of Equiv. No. People)
1946	0		N	
1947	1	2,500	O	
1948	2	17,250	D	
1949	7	259,500	A	
1950	2	8,500	T	
1951*	2	140,000	A	*

* January-June only

The State Engineer is granted by law general supervision over all waters of the State, including their measurement, appropriation, and distribution.

The State Department of Public Health has been designated as the State Water Pollution Control Agency pursuant to the provisions of the Federal Water Pollution Control Law.

In Arizona the State Department of Health was designated as the State Water Pollution Control Agency, pursuant to the provisions of the Federal Water Pollution Control Law.

The State Board of Health is empowered by law to set up rules and regulations to "regulate sanitation and sanitary practices in the interests of public health" which are administered by the State Department of Health. The Game and Fish Commission is authorized to bring suit against anyone polluting water so that it may be injurious to fish or wildlife. The general Code contains a provision (see below) enforceable by the authorities of the local political subdivision which is designed to prevent pollution of water which may "become unhealthful or offensive." Incorporated towns and full time local health units in some cases have additional ordinances which regulate sanitary practices.

ARIZONA CODE - Annotated 1939

43-4604. Polluting waters -- Nuisances on streets and roads. -- Every person who puts the carcass of any dead animal, or the offal from any slaughter pen, corral or butcher shop into any river, creek, pond, reservoir, stream, street, alley, or road in common use, or who attempts to destroy the same by fire within one-fourth of a mile of any city or town, except it be in a crematory, the construction and operation of which is satisfactory to the board of health of such city or town; and any person who puts any water-closet or privy, or the carcass of any dead animal or any offal of any kind, in or upon the borders of any stream, pond, lake or reservoir from which water is drawn for the supply of the inhabitants of any city or town, or who allows any water-closet or privy, or carcass of any dead animal, or any offal of any kind, to remain in or upon the borders of any such stream, pond, lake or reservoir within the boundaries of any land owned or occupied by him, so that the drainage from such water-closet, privy, carcass or offal may be taken up by or in such stream, pond, lake or reservoir; or who keeps any horses, mules, cattle, swine, sheep or livestock of any kind penned, corralled or housed on, over, or on the borders of any such stream, pond, lake or reservoir, so that the waters thereof become polluted by reason thereof, or who bathes in any such stream, pond, lake or reservoir; or who by any other means fouls or pollutes the waters of any such stream, pond, lake or reservoir; or the owner or person in possession of any lot of land in any city or town, incorporated or unincorporated, on which there is any water-closet, privy, or cesspool, who shall permit the same to become unhealthful or offensive to the public, or to any person, is guilty of a misdemeanor. (P. C. 1901.)

POLLUTION PREVENTION MEASURES REQUIRED

The data in Table H reveal that less than two-fifths of the domestic waste treatment plants--serving less than one-third of the sewered population--are in need of corrective action. The principal need of the Gila Basin is for new and extended sewerage systems to serve those areas in Arizona now lacking these facilities.* The requirements for industrial waste treatment in the Gila Basin are not so clear but have been listed, insofar as available data permit, in Table I.

The current status of municipal and industrial action in providing needed facilities are shown in Tables J and K. The inactivity towards further pollution abatement action, so clearly indicated in these tables, emphasizes the need for a well defined comprehensive program of pollution abatement that can be adopted as a recognized future policy.

The specific pollution prevention and control measures required by sewered communities and industries--which are recognized at the present time--are listed in Table L. The cost of providing these needed facilities at this time is estimated by the State Health Authorities at $1,600,000 for municipal wastes and $175,000 for the industrial wastes (1948 cost figures).

It is emphasized that these cost data apply only to communities that now have waste collection systems and/or to industries known to produce a damaging effluent.

There are also in the Gila Basin many communities currently unsewered at which waste collection systems and, in some instances, waste treatment facilities are needed. These communities have been listed according to their respective needs under Appendix II. The cost of providing the facilities needed at these unsewered communities is estimated at $8,970,000 (1948 cost figures) by the Arizona State Department of Health.

Further knowledge of the Gila Basin presumably will reveal additional industries with polluting wastes at which waste treatment facilities will be needed.

The State regulatory agencies lack sufficient personnel and funds to develop and administer a comprehensive program of pollution prevention control that will assure clean waters to the State. Present State technical personnel for survey and investigational work are so limited that any comprehensive pollution abatement program will be long-term at best in the development stage with a resultant delay in the realization of benefits. The provision of sufficient personnel and funds to back an effective abatement program must, in the final analysis, depend upon an enlightened public. The State agencies are woefully short of funds to obtain the background data necessary or to prosecute a public education program were the facts known. Full pollution control is extremely important because the future of the Gila Basin depends, in large measure, upon the assurance and maintenance of clean waters.

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* See Appendix II

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The Arizona State Department of Health for some time has been attempting to secure passage by the Legislature of an effective water pollution control law. Their control authority currently is derived principally from regulations and not law.

TABLE H

WASTES TREATMENT NEEDS - MUNICIPAL*

Needs	Number	Population Served by Facilities
New Plant	2	8,400
Enlargement or additions to existing plant	13	32,870
Replace Existing Plant	13	43,900
No Project Required	48	259,858
Undetermined	1	1,250

* Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers or other population centers.

TABLE I

INDUSTRIAL* WASTE POLLUTION ABATEMENT NEEDS

Needs	Number
New Treatment Plant or other Pollution Control Measures	5
Enlargement or Additions to Existing Plant	5
Replace Existing Plant	9
Connection to Municipal Sewer System	3
No project Required	19
Undetermined	17

* Industries having separate outlets discharging wastes directly to watercourse.

TABLE J
CURRENT STATUS OF MUNICIPAL* ACTION ON
POLLUTION ABATEMENT NEEDS

Status of Action	Number of Municipalities*
Inactive	20
Active Planning	7
Final Plans Approved	0
Under Construction	1

* Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers or other population centers.

TABLE K
CURRENT STATUS OF INDUSTRIAL* ACTION ON
POLLUTION ABATEMENT NEEDS

Status of Action	Number of Industries*
Inactive	18
Active Planning	3
Final Plans Approved	0
Under Construction	1
Undetermined	0

* Industries having separate outlets discharging wastes directly to watercourse.

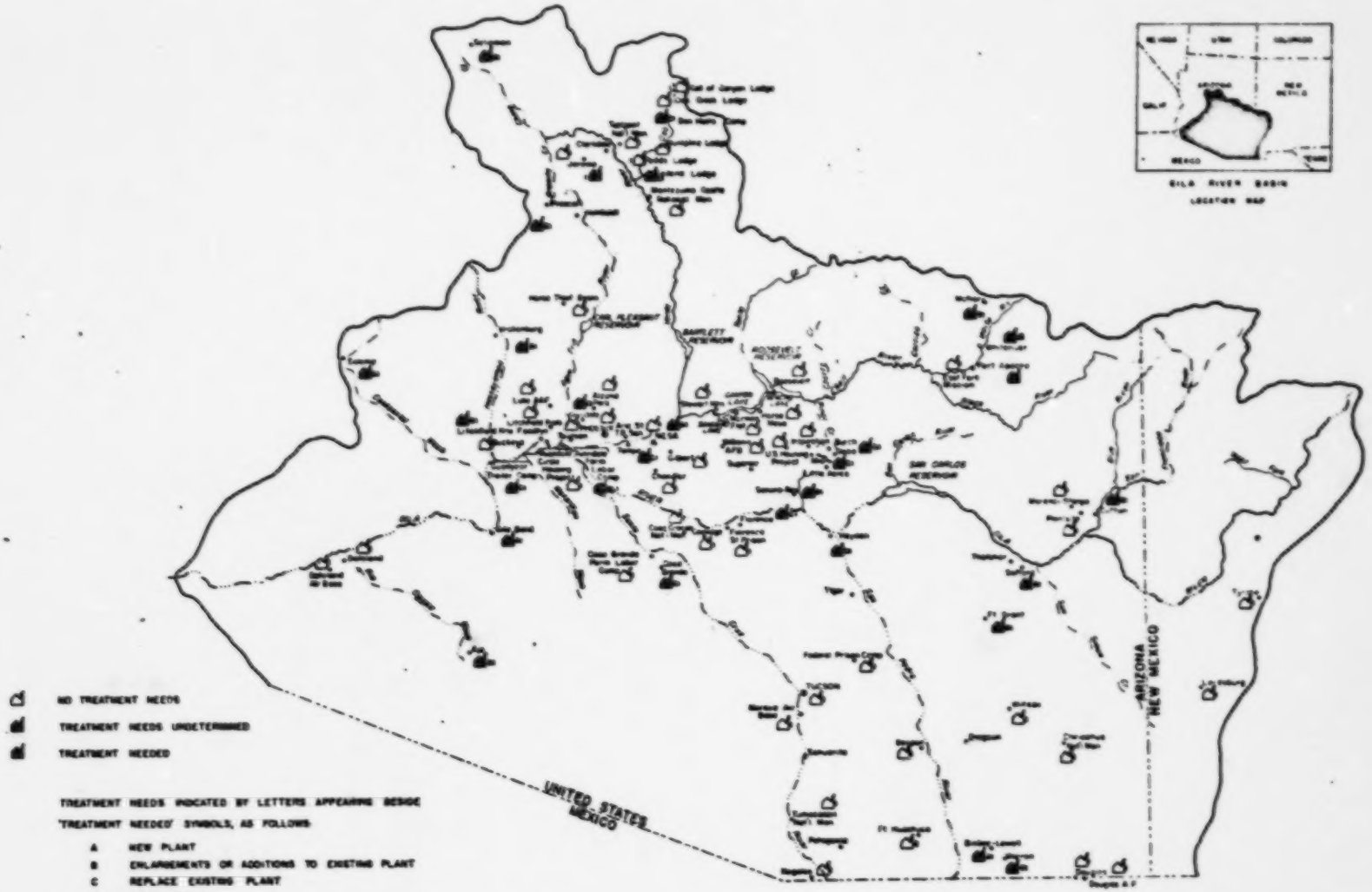
TABLE L
MUNICIPALITIES AND INDUSTRIES NEEDING
IMPROVEMENTS FOR ABATEMENT OF POLLUTION

February 1, 1952

Name and Location	Population Served	Improvement Needed	Remarks
NEW MEXICO			
Lordsburg		Effluent	
Southern Pac. R. R.		Channel	
ARIZONA			
Ajo	8,000	Enlargement	
Avondale Farm Labor Camp	1,400	Additions	Active planning
Bisbee-Lowell	8,000	New plant	Under construction
Casa Grande	3,900	Replacement	
Paramount Packing Co.	500 (E)	Replacement	
Clifton	3,500	Replacement	
Don Hoels Camp, Oak Creek	50	Enlargement	
Florence	3,000	Replacement	
Fort Apache	200	Replacement	
Fort Grant	120	Additions	
Gila Bend	400	New plant	
Glendale	8,500	Replacement	Active planning
Associated Dairy		city sewer con.	
Double Seven Corp.		Replacement	
Globe	6,500	Additions	Active planning
Daou Packing Co.		Additions	
Goodyear Trailer Camp	400	Replacement	Acting planning
Hayden	1,000	Replacement	
Litchfield Park			
Goodyear Aircraft Co.		Additions	Active planning
Litchfield Naval Air Fac.	500	Additions - San. Sewage	Active planning
Litchfield Naval Air Fac.		New plant - Industrial Waste	Active planning

(E) - Estimated

Name and Location	Population Served	Improvement Needed	Remarks
Little Acres			
Patrick's Dairy		Replacement	
Lowell			
Phelps-Dodge Corp.		Additions (Industrial plant)	
McNary	800	Additions	
Mesa	9,000	Additions	
Miama	4,300	Replacement	
7-Up Bottling Co.	80(E)	New plant	
Phoenix			
Golden Meat Packing Co.		Replacement	
Maricopa Packing Co.		Replacement	
Tru-Ade Bottling Co.		Replacement	
Western Packing Co.		Replacement	
Prescott	7,000	Replacement	Active planning
Hassayampa Dairy		Replacement	
Safford	3,800	Additions	
Safford Packing Co.		Replacement	
Salome	200	Replacement	
Sedona Lodge	400	Replacement	
Seligman	150	Additions	
Sonora-Ray	2,250	Additions	Active planning
Kennecott Copper Co.		Additions	Active planning
Tempe	10,000	Replacement	
Tempe Meat Company	820(E)	New plant	
Thatcher			
Farley's Milk Plant		New plant	
Tucson			
Dr. Pepper Bottling Co.		City sewer connec.	
Grand Central Aircraft Co.		New plant	Under construction
Shamrock Dairy	250(E)	City sewer connec.	
Warren	3,500	Replacement	
White River	200	Additions	
Wickenburg	2,100	Enlargement	



GILA RIVER BASIN
LOCATION MAP

NO TREATMENT NEEDS

TREATMENT NEEDS UNDETERMINED

TREATMENT NEEDED

TREATMENT NEEDS INDICATED BY LETTERS APPEARING BESIDE
'TREATMENT NEEDED' SYMBOLS, AS FOLLOWS

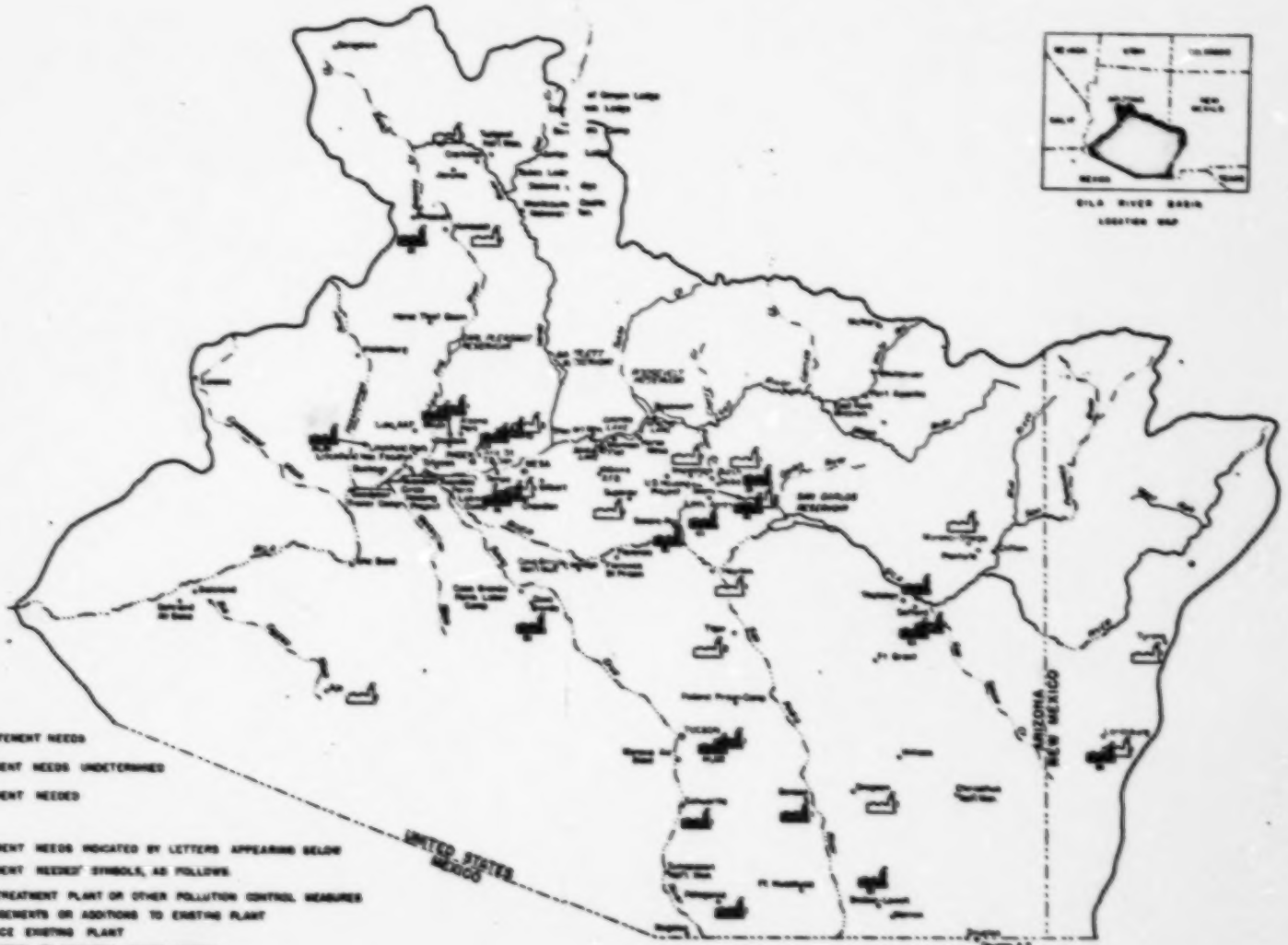
- A NEW PLANT
- B ENLARGEMENTS OR ADDITIONS TO EXISTING PLANT
- C REPLACE EXISTING PLANT
- CL CHLORINATION

NOTE
Numbers next to symbols or next to each letter represent number of treatment needs in the category designated

SCALE OF MILES
0 1 2 3 4 5 6 7

GILA RIVER BASIN
MUNICIPAL
WASTE TREATMENT NEEDS
FEDERAL SECURITY AGENCY
Public Health Service
DIVISION OF WATER POLLUTION CONTROL
MAP NO. 6

35-A



NO POLLUTION ABATEMENT NEEDS

POLLUTION ABATEMENT NEEDS UNDETERMINED

POLLUTION ABATEMENT NEEDED

POLLUTION ABATEMENT NEEDS INDICATED BY LETTERS APPEARING BELOW POLLUTION ABATEMENT NEEDED' SYMBOLS, AS FOLLOWS:

- A. NEW TREATMENT PLANT OR OTHER POLLUTION CONTROL MEASURES
- B. ENLARGEMENTS OR ADDITIONS TO EXISTING PLANT
- C. REPLACE EXISTING PLANT
- D. CONNECTION TO MUNICIPAL SEWER SYSTEM

NOTE: Numbers next to symbols or next to each letter represent number of pollution abatement needs in the category designated

SCALE OF MILES

35-b

GILA RIVER BASIN
INDUSTRIAL
POLLUTION ABATEMENT NEEDS
FEDERAL SECURITY AGENCY
PUBLIC HEALTH SERVICE
DIVISION OF WATER POLLUTION CONTROL
MAP NO. 8

APPENDIX I

Table 1	Basic Data on Sources of Municipal Pollution - Gila Basin
Table 2	Basic Data on Sources of Industrial Pollution - Gila Basin

APPENDIX II

POLLUTION PREVENTION MEASURES REQUIRED IN UNSEWERED ARIZONA COMMUNITIES

TABLE 1
BASIC DATA ON SOURCES OF MUNICIPAL* POLLUTION
GILA BASIN

Name and Location	River Miles Above Mouth Outlet Stream	Population Served By Sewers	P.E. (BOD) Untreated Wastes	Waste Treatment Provided	Adequacy of Treatment Facilities Cap'y	Adequacy of Treatment Facilities Opr.	P.E. (BOD) Discharged to water course**	Treatment Needs	Current Status Municipal* Action
I. Willcox Basin (Drainage to Mexico)									
Fort Grant		120		Primary	Unsat.	Unsat.		Addition	Inactive
Willcox		1,100		Secondary	Sat.	Sat.		None	
Chiricahua Nat. Mon.		100		Secondary	Sat.	Sat.		None	
Bisbee-Lowell		8,000		None					New plant under const.
Warren		3,500		Primary	Unsat.	Sat.		Replacement	Inactive
Douglas		11,000		Secondary	Sat.	Unsat.		None	
Douglas Air Field		90		Primary	Sat.	Sat.		None	
II. Animas (Desiccating Basin)									
Lordsburg, N. Mex.		2,150		Secondary	Sat.	Sat.		None	
Tyrone, N. Mex.		120		Secondary	Sat.	Sat.		None	
III. Gila River									
A. San Francisco River enters	G-427								
Safford	G-402	3,800		Primary	Unsat.	Sat.		Addition	Inactive
Hayden	G-305	1,000		Primary	Undet.	Undet.		Replacement	Inactive
B. San Pedro Riv. enters	G-305								
C. Mineral Creek enters	G-290								
Florence	G-262	3,000		Primary	Unsat.	Unsat.		Replacement	

* Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers or other population centers.

** Includes industrial wastes discharged into municipal sewerage systems.

TABLE 1

BASIC DATA ON SOURCES OF MUNICIPAL* POLLUTION

GILA BASIN

	Name and Location	River Miles Above Mouth Outlet Stream	Population Served by Sewers	P.E. (BOD) Untreated Wastes	Waste Treatment Provided	Adequacy of Treatment Facilities: Cap'y	Adequacy of Treatment Facilities: Opr.	P.E. (BOD) Discharged to water course**	Treatment Needs	Current Status Municipal* Action
	Florence State Prison	G-260	600		Secondary	Sat.	Sat.		None	
	Coolidge	G-255	2,000		Secondary	Sat.	Sat.		None	
	Casa Grande Nat. Mon.	G-255	250		Primary	Undet.	Undet.		None	
	Williams Air Force Base		5,000		Secondary	Sat.	Sat.		None	
	Gilbert		1,100		Secondary	Sat.	Sat.		None	
	Chandler		4,500		Secondary	Sat.	Sat.		None	
D.	Santa Cruz Riv. enters	G-206								
E.	Salt River enters	G-200								
F.	Agua Fria enters	G-197								
	Litchfield Naval Air Facility	G-196	500		Primary	Unsat.	Sat.		Addition	Active plan
	Buckeye	G-182	750		Secondary	Sat.	Sat.		None	
G.	Hassayampa Riv. enters	G-173								
	Gila Bend		400		None				New plant	Inactive
H.	Centennial Wash enters	G-165								
I.	Rio Cornez enters									
	Datelan	G-62	50		Secondary	Sat.	Sat.		None	
	Datelan Air Base	G-60	8		Secondary	Sat.	Sat.		None	
II.A.	San Francisco River									
	Morenci-Stargo	SF-8	5,000		Primary	Sat.	Sat.		None	
	Plant site		2,000		Primary	Sat.	Sat.		None	
	Clifton	SF-8	3,500		Primary	Unsat.	Unsat.		Replacement	Inactive
II.B.	San Pedro River									
	Fort Huachuca #1	SP-109	6,000		Primary	Sat.	Sat.		None	
	Fort Huachuca #2		6,000		Primary	Sat.	Sat.		None	
	Benson	SP-81	750		Secondary	Sat.	Sat.		None	
II.C.	Mineral Creek									
	Sonora-Ray	M-6	2,250		Primary	Unsat.	Sat.		Additions	Active plan.

(See footnotes at beginning of Table - page 37)

Name and Location	River Miles Above Mouth Outlet Stream	Population Served by Sewers	P.E. (BOD) Untreated Wastes	Waste Treatment Provided	Adequacy of Treatment Facilities Cap'y	Adequacy of Treatment Facilities Opr.	P.E. (BOD) Discharged to water courses	Treatment Needs	Current Status Municipal Action
II.D. Santa Cruz River									
Nogales	SC-175	12,000		Secondary	Sat.	Sat.		None	
Tumacacori Nat. Mon.		100		Secondary	Sat.	Sat.		None	
Tucson	SC-115	60,000	46,300	Secondary	Sat.	Sat.	6,300	None	
Fed. Prison - Tucson	SC-115	300		Secondary	Sat.	Sat.		None	
Marana Air Base		1,300		Secondary	Sat.	Sat.		None	
Casa Grande	SC-45	3,900		Secondary	Unsat.	Unsat.		Replacement	Inactive
Casa Grande Farm Labor Camp	SC-40	1,200		Secondary	Sat.	Sat.		None	
II.E. Salt River									
1. White River enters	S-169								
2. Pinal Creek enters	S-104								
Roosevelt		30		Secondary	Sat.	Sat.		None	
Horse Mesa	S-70	100		Secondary	Sat.	Sat.		None	
Morrion Flat	S-61	20		Secondary	Sat.	Sat.		None	
Stewart Mt.	S-51	25		Secondary	Sat.	Sat.		None	
3. Verde Riv. enters	S-41								
Mesa	S-28	7,000		Primary	Unsat.	Sat.		Addition	Inactive
Tempe	S-22	8,000		Secondary	Unsat.	Unsat.		Replacement	Inactive
Arizona State TB San.	S-20	200		Secondary	Sat.	Sat.		None	
Phoenix	S-12	120,000	150,000	Secondary	Sat.	Sat.	1,460	None	
Alsona Park		5,000		Secondary	Sat.	Sat.		None	
1. White River									
McNary	W-36	800		Primary	Unsat.	Unsat.		Addition	Inactive
Whiteriver	W-20	200		Primary	Unsat.	Unsat.		Addition	Inactive
East Fork Mission	W-16	300		Secondary	Sat.	Sat.		None	
Port Apache		200		Primary	Unsat.	Unsat.		Replacement	Inactive
2. Pinal Creek									
Globe	PC-18	6,500		Primary	Unsat.	Unsat.		Addition	Act. planning
2a Bloody Tanks Wash enters	PC-14								

(See footnotes at beginning of Table - page 37)

Name and Location	River Miles Above Mouth Outlet Stream	Population Served by Sewers	P.E. (BOD) Untreated Wastes	Waste Treatment Provided	Adequacy of Treatment Facilities: Cap'y	Adequacy of Treatment Facilities: Opr.	P.E. (BOD) Discharged to water course**	Treatment Needs	Current Status Municipal* Action
2a Bloody Tanks Wash									
Miami	BT-6	4,300		Secondary	Unsat.	Unsat.		Replacement	Inactive
U.S. Housing Project, Miami	BT-5	600		Secondary	Sat.	Sat.		None	
Inspiration	BT-4	500		Secondary	Sat.	Sat.		None	
3. Verde River									
a. Chino Creek enters	V-148								
b. Granite Creek enters	V-148								
Jerome	V-113	1,250		Primary	Undet.	Undet.		Undet.	
Clarkdale	V-113	1,600		Secondary	Sat.	Sat.		None	
Tuzigoot Nat. Mon.		100		Secondary	Sat.	Sat.		None	
c. Oak Creek enters	V-101								
d. Wet Beaver Creek enters									
3a Chino Creek									
Seligman	CC-47	150		Primary	Unsat.	Unsat.		Additions	Inactive
3b Granite Creek									
Prescott	GC-25	7,000		Secondary	Unsat.	Unsat.		Replacement	Act. planning
3c Oak Creek									
Call of Canyon Lodge		75		Secondary	Sat.	Sat.		None	
Oak Creek Lodge		50		Secondary	Sat.	Sat.		None	
Don Hoels Camp		50		Secondary	Unsat.	Sat.		Enlargement	Inactive
Junipine Lodge		20		Secondary	Sat.	Sat.		None	
Sedona Lodge		400		Primary	Unsat.	Unsat.		Replacement	Inactive
Todd's Lodge		20		Secondary	Sat.	Sat.		None	
3d Wet Beaver Creek									
Montezuma Castle Nat. Mon.		100		Secondary	Sat.	Sat.		None	
F. Agua Fria River									
1. Black Canyon Creek enters	AF-54								
Glendale	AF-12	8,500		Primary	Unsat.	Unsat.		Replacement	Act. plan.
Luke Army Air Field	AF-11	3,000		Secondary	Sat.	Sat.		None	

(See footnotes at beginning of Table - page 37)

Name and Location	River Miles Above Mouth Outlet Stream	Population Served by Sewers	P.E. (BOD) Untreated Wastes	Waste Treatment Provided	Adequacy of Treatment Facilities: Cap'y	Adequacy of Treatment Facilities: Opr.	P.E. (BOD) Discharged to water course**	Treatment Needs	Current Status Municipal* Action
Litchfield Park	AF-6	500		Primary	Sat.	Sat.		None	
Avondale Farm Labor Camp	AF-5	1,400		Secondary	Unsat.	Sat.		Additions	Active plan.
Tolleson	AF-4	3,500		Primary	Sat.	Sat.		None	
Avondale Circle Housing Project	AF-3	350		Secondary	Sat.	Sat.		None	
Goodyear Trailer Camp		400		Primary	Unsat.	Unsat.		Replacement	Active plan.
1. Black Canyon Creek									
Horse Thief Basin	BC-15	300		Secondary	Sat.	Sat.		None	
G. Hassayampa River									
Wickenburg	H-49	2,100		Secondary	Unsat.	Unsat.		Enlargement	Inactive.
H. Centennial Wash									
Salome	C-64	200		Secondary	Unsat.	Unsat.		Replacement	Inactive
I. Rio Cornez									
Ajo		8,000		Primary	Unsat.	Sat.		Enlargement	Inactive

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(See footnotes at beginning of Table - page 37)

TABLE 2

BASIC DATA ON SOURCES OF INDUSTRIAL* POLLUTION

GILA BASIN

Name and Location	River Miles Above Mouth Outlet Stream	Type Industry	Type Waste Produced	Treatment or other Pollution Control Measures: Degree	Adequacy Cap'y	Adequacy Opr.	P.E. (BOD) Discharged to watercourse	Pollution Abatement Needs	Current Status Industrial* Action
I. Willcox Basin (Drainage to Mexico)									
Dragoon									
Coronado Copper & Zinc Co.		Prim.Metals	Inorganic	Secondary 1/	Sat.	Sat.		None	
Lowell									
Phelps Dodge Corp.		Prim.Metals	Inorganic	Chemical	Unsat.	Unsat.		Additions	Inactive
II. Animas (Desiccating Basin)									
Lordsburg, N. Mex.									
Southern Pac. R.R.		Miscellaneous	Organic	Secondary	Sat.	Unsat.		Additions	Inactive
Banner Copper Mine		Prim.Metals	Inorganic	Secondary 1/	Sat.	Sat.		None	
Tyrone, N. Mex.									
Phelps-Dodge Corp.		Prim.Metals	Inorganic	None 2/				None	
III. Queen Creek (Desiccating Basin)									
Superior									
Magma Copper Co.		Prim.Metals	Inorganic	Secondary 1/	Sat.	Sat.		None	
IV. Gila River									
A. San Fran. River									
enters	G-427								
Safford	G-402								
Nelson's Dairy		Food	Organic	Secondary 2/	Undet.	Undet.		Undet.	
Safford Pack. Co.		Food	Organic	Secondary 2/	Unsat.	Unsat.		Replacement	Inactive
Thatcher	G-397								
Farley's Milk Plant		Food	Organic	None				New Plant	Inactive

1/ All liquid wastes recycled to conserve water

2/ Wastes do not reach flowing water

3/ Processes "mothballed" airplanes

* Industries having separate outlets and discharging wastes directly to watercourse.

(E) Estimated

Name and Location	River Miles Above Mouth Outlet Stream	Type Industry	Type Waste Produced	Treatment or other Pollution Control Measures: Degree	Adequacy Cap'y	Adequacy Opr.	P.E. (BOD) Discharged to water-course	Pollution Abatement Needs	Current Status Industrial Action
Hayden	G-305								
Kennecott Copper Co.		Prim.Metals	Inorganic	Secondary 1/	Sat.	Sat.		None	
B. San Pedro Riv. enters	G-305								
C. Mineral Creek enters	G-290								
D. Santa Cruz River enters	G-206								
E. Salt River enters	G-200								
F. Agua Fria River enters	G-197								
Glendale									
Associated Dairy		Food	Organic	Chemical	Unsat.	Unsat.		Pre-tmt.& City sewer connec.	Inactive
Litchfield Park	G-196								
Litchfield Naval Air Facility		Misc. 3/	Organic	None				New plant	Act. plan.
Goodyear Aircraft Company		Misc.	San Sewage	Primary	Unsat.	Sat.		Additions	Act. plan.
G. Hassayampa River enters	G-173								
H. Rio Cornez Wash enters									
A. San Francisco River									
Morenci-Stargo									
Phelps-Dodge Corp.	SF-8	Prim.Metals	Inorganic	Secondary 1/	Sat.	Sat.		None	
B. San Pedro River									
Benson	SP-81								
Apache Powder Co.		Chemical	Undet.	Secondary	Undet.	Undet.		Undet.	
Apache Powder Co.		Chemical	San Sewage	Secondary 2/	Sat.	Sat.		None	
Tiger	SP-21								
St. Anthony Mining & Devel Co.		Prim.Metals	Inorganic	Secondary 1/	Sat.	Sat.		None	
San Manuel Copper Co.		Prim.Metals	Inorganic	Secondary 1/	Sat.	Sat.		None	
San Manuel Copper Co.		Prim.Metals	San.Sewage	Primary	Sat.	Sat.		None	

(See footnotes at beginning of Table - page 42)

Name and Location	River Miles Above Mouth Outlet Stream	Type Industry	Type Waste Produced	Treatment or other Pollution Control Measures: Degree	Adequacy Cap'y	Adequacy Opr.	P.E. (BOD) Discharged to water-course	Pollution Abatement Needs	Current Status Industrial* Action
C. Mineral Creek									
Sonora-Ray	M-6								
Kennecott Copper Co.		Prim.Metals	Inorganic	Primary	Sat.	Sat.		Additions	Act. Plan.
D. Santa Cruz River									
Sahuarita	SC-135								
Eagle Pitcher Mining & Smelt. Co.		Prim.Metals	Inorganic	Undet.				Undet.	
Tucson	SC-115								
Dr. Pepper Bottling Co.		Food	Organic	Secondary	Undet.	Undet.		To city sewer	Inactive
Shamrock Dairy		Food	Organic	Secondary	Undet.	Undet.	250(E)	To city sewer	Inactive
Tucson Tallow Works		Food	Organic	Secondary 2/	Undet.	Undet.		Undet.	
Grand Central Aircraft		Misc. 3/	Organic	None				New plant	Under construction
Patagonia									
American Smelting & Refining Co.		Prim.Metals	Incrganic	Secondary 1/	Undet.	Undet.		Undet.	
Casa Grande	SC-45								
Paramount Pack. Co.		Food	Organic	Primary	Unsat.	Unsat.	500(E)	Replacement	Inactive
E. Salt River									
1. Pinal Creek enters	S-104								
2. Verde Riv. enters	S-41								
Tempe	S-22								
The Borden Co.		Food	Organic	Secondary 2/	Sat.	Sat.		None	
Tempe Meat Co.		Food	Organic	None			820(E)	New plant	Inactive
Maricopa Tallow Works		Food	Organic	Undet.				Undet.	
Phoenix	S-12								
Western Pack. Co.		Food	Organic	Secondary	Unsat.	Unsat.		Replacement	Inactive
Cudahy Pack. Co.		Food	Organic	Secondary	Sat.	Sat.		None	

(See footnotes at beginning of Table - page 42)

Name and Location	River Miles Above Mouth Outlet Stream	Type Industry	Type Waste Produced	Treatment or other Pollution Control Measures: Degree	Adequacy Cap'y	Adequacy Opr.	P.E. (BOD) Discharged to watercourse	Pollution Abatement Needs	Current Status Industrial* Action
Maricopa Pack. Co.		Food	Organic	Secondary	Unsat.	Unsat.		Replacement	Inactive
Golden Meat Pack. Co.		Food	Organic	Secondary	Unsat.	Unsat.		Replacement	Inactive
Gilco Corporation		Chemical	Undet.	None				Undet.	
Arizona Fertilizer Co.		Chemical	Undet.	None				Undet.	
Deero Paint & Chem. Co.		Chemical	Undet.	None				Undet.	
Agricultural Prod. Co.		Chemical	Undet.	None				Undet.	
Reynolds Met. Co.		Fab.Metals	Inorganic	Secondary	Sat.	Sat.		None	
R. A. Cleaners		Misc.	Organic	Secondary	Undet.	Undet.		Undet.	
Payless Cleaners		Misc.	Organic	Secondary	Undet.	Undet.		Undet.	
Champion Clothers Cleaners		Misc.	Organic	Secondary	Undet.	Undet.		Undet.	
Tru-Ade Bottling Co.		Food	Organic	Secondary	Unsat.	Unsat.		Replacement	Inactive
Home Dairy		Food	Organic	Secondary 2/	Undet.	Undet.		Undet.	
Kruft's Dairy		Food	Organic	None			75(E)	Undet.	
Westward Ho Dairy		Food	Organic	Secondary	Undet.	Undet.		Undet.	
Motorola Corp.		Misc.	Inorganic	Secondary	Sat.	Sat.		None	
El. Pinal Creek									
Globe	PC-18								
Dacu Packing Co.		Food	Organic	Primary	Unsat.	Unsat.		Additions	Inactive
Bloody Tanks Wash enters	PC-14								
Burch									
Burch Dairy		Food	Organic	Secondary	Sat.	Sat.		None	
Bloody Tanks Wash									
Miami	BT-6								
7-Up Bottling Co.		Food	Organic	None			80(E)	New plant	Inactive
Miami Copper Co.		Prim.Metals	Inorganic	Secondary	Sat.	Sat.		None	
Inspiration	BT-4								
Inspiration Cop. Co.		Prim.Metals	Inorganic	Secondary 1/	Sat.	Sat.		None	

(See footnotes at beginning of Table - page 42)

Name and Location	River Miles Above Mouth Outlet Stream	Type Industry	Type Waste Produced	Treatment or other Pollution Control Measures: Degree	Adequate Cap'y	Adequate Opr.	P.E. (BOD) Discharged to water-Course	Pollution Abatement Needs	Current Status Industrial* Action
Little Acres									
Patrick's Dairy		Food	Organic	Secondary	Unsat.	Unsat.		Replacement	Inactive
Pinto Creek									
Castle Dome Copper Co.		Prim.Metals	Inorganic	Secondary 1/	Sat.	Sat.		None	
E2. Verde River									
Granite Creek enters	V-148								
Clarkdale	V-113								
Phelps Dodge Corp.		Prim.Metals	Inorganic	Secondary 1/	Sat.	Sat.		None	
Granite Creek									
Prescott	GC-25								
Hassayampa Dairy		Food	Organic	Secondary 2/	Unsat.	Unsat.		Replacement	Inactive
F. Agua Fria River									
Humboldt	AF-93								
Shattuck Denn Co.		Prim.Metals	Inorganic	Secondary	Sat.	Sat.		None	
Glendale	AF-12								
Double 7 Corp.		Food	Organic	Secondary 2/	Unsat.	Unsat.		Replacement	Inactive
The Squirt Co.		Food	Organic	None				Undet.	
G. Hassayampa River									
H. Rio Cornez Wash									
Ajo									
Phelps Dodge Corp.		Prim.Metals	Inorganic	Secondary 1/	Sat.	Sat.		None	

(See footnotes at beginning of Table - page 42)

APPENDIX XI

POLLUTION PREVENTION MEASURES REQUIRED IN UNSEWERED ARIZONA COMMUNITIES

The greatest pollution prevention need of the Gila Basin involves a complete collection system and treatment plant, as well as the extension of existing sewer lines, in various communities of Arizona. Unsewered communities were not included in the text of this report.

The Arizona State Department of Health recommends, in the interests of public health, both a collection system and an adequate treatment plant to serve the population indicated at the following communities:

Ash Fork	800	Oracle	500
Avondale	2,500	Patagonia	700
Bowie	500	Peoria	1,200
Bylas	750	Peridot	800
Camp Verde	500	Pima	800
Central Heights	1,300	Sacaton	600
Cottonwood	1,500	Saguaro Nat. Mon.	50,000/year
Duncan	1,500	Saint David	500
El Mirage	1,100	San Carlos	1,500
Eloy	3,600	Scottsdale	2,000
Forbing Park	300	Sedona	300
Gibson	1,000	Solomonsville	7,700
Goodyear	1,300	Summerhaven	1,000
Humboldt	400	Superior	5,000
Little Acres	150	Surprise	1,200
Mammoth	500	Thatcher	1,300
Maverick*	500	Tiger	1,200
Mayer	500	Tombstone	1,000
Millery Valley	3,500	Winkelman	600

The cost of providing sewerage and treatment facilities at the communities in the above list is estimated at $2,270,000 (1948 cost figures) by Arizona health authorities.

* Plans approved and funds available for construction of both sewers and treatment plant.

In addition, there are unsewered fringe areas about many Arizona communities which the State Department of Health also recommends be served by extensions of existing community sewers. In some instances, additional treatment facilities may be required to accommodate the increased loading. The recommended population to be served is given for each community:

Benson	800
Buckeye	1,200
Casa Grande	600
Coolidge	3,500
Douglas	2,200
Florence	500
Gila Bend	600
Glendale	4,000
Hayden	1,000
McNary	1,700
Mesa	7,800
Phoenix	115,000
Safford	1,000
Salome	250
Seligman	500
Sells	600
Sonora-Ray	500
Tempe	2,000
Tuscon	70,000
Willcox	400

The cost of providing the needed additional sewerage at the communities listed above is estimated at $6,700,000 (1948 cost figures) by the Arizona health authorities.